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HOSKINS-WESTERN-SONDEREGGER INC LINCOLN NE
NATIONAL DAM SAFETY PROGRAM. CURT LEE DAM (MO 10664), GRAND - C-ETC(U)
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CURT LEE DAM

GENTRY COUNTY, MISSOURI

MO. 10664

**PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM**

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FOR: STATE OF MISSOURI

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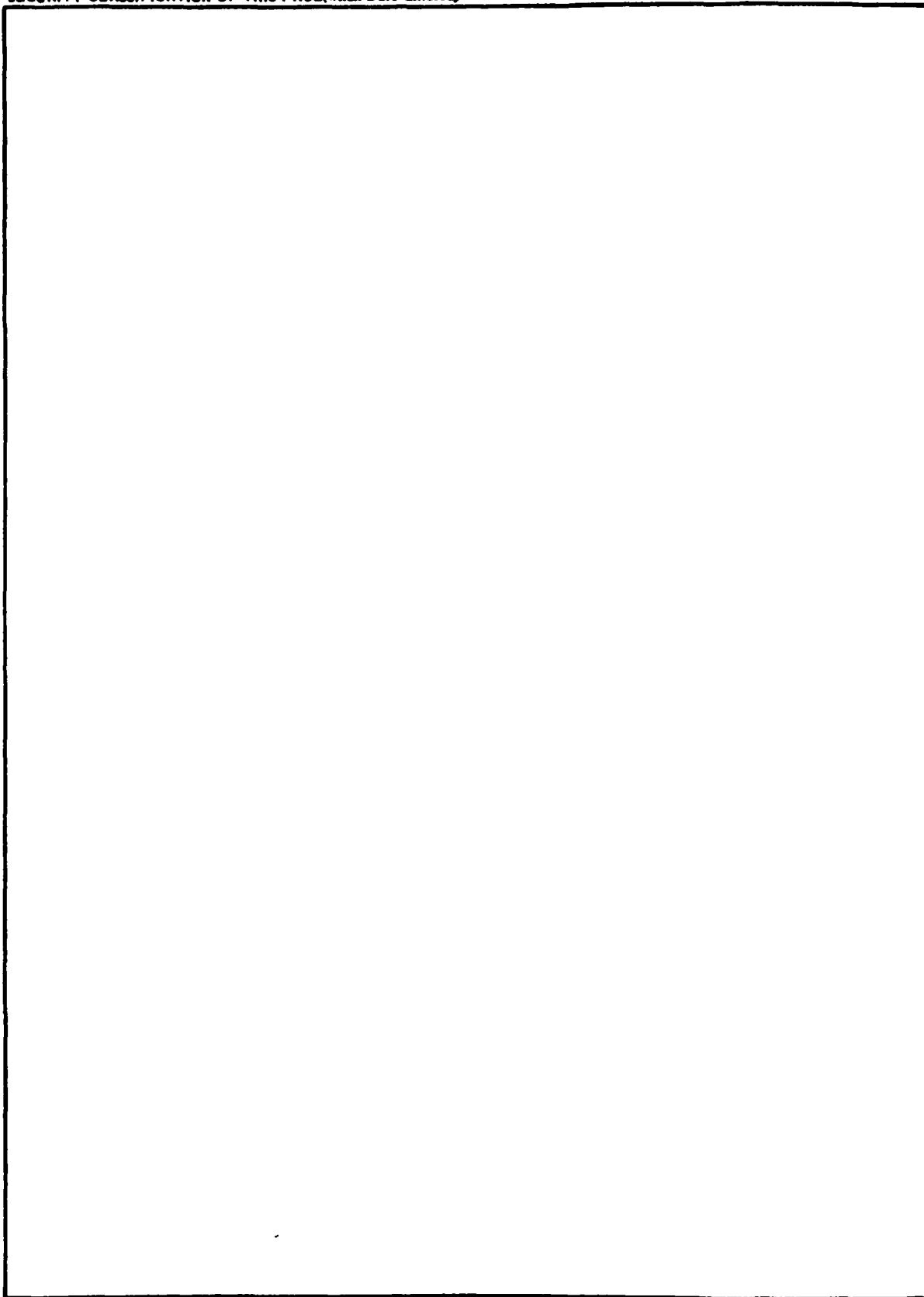
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| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property. | | | |

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)



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15 DACW43-79-C-0046

10 Rey S. /Decker Gordon G. /Jamison
Garold /Ulmer Harold P. /Hoskins

CURT LEE DAM

GENTRY COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10664

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM.

Curt Lee Dam (MO 10664),
Grand - Chariton Basin, Gentry County,
Missouri. Phase I Inspection Report.

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Curt Lee Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Curt Lee Dam:

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood.
- 2) Overtopping could result in dam failure.
- 3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY SIGNED 20 SEP 1979
Chief, Engineering Division Date

APPROVED BY: SIGNED 20 SEP 1979
Colonel, CE, District Engineer Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

TABLE OF CONTENTS

| <u>PARAGRAPH NO.</u> | <u>TITLE</u> | <u>PAGE NO.</u> |
|----------------------|---|-----------------|
| | Assessment Summary | |
| | Overview Photograph | |
| | SECTION 1 - PROJECT INFORMATION | 1 |
| 1.1 | General | 1 |
| 1.2 | Description of Project | 1 |
| 1.3 | Pertinent Data | 3 |
| | SECTION 2 - ENGINEERING DATA | 5 |
| 2.1 | Design | 5 |
| 2.2 | Construction | 5 |
| 2.3 | Operation | 5 |
| 2.4 | Evaluation | 5 |
| | SECTION 3 - VISUAL INSPECTION | 6 |
| 3.1 | Findings | 6 |
| 3.2 | Evaluation | 8 |
| | SECTION 4 - OPERATIONAL PROCEDURES | 9 |
| 4.1 | Procedures | 9 |
| 4.2 | Maintenance of Dam | 9 |
| 4.3 | Maintenance of Operating Facilities | 9 |
| 4.4 | Description of Any Warning System in Effect | 9 |
| 4.5 | Evaluation | 9 |
| | SECTION 5 - HYDRAULIC/HYDROLOGIC | 10 |
| 5.1 | Evaluation of Features | 10 |
| | SECTION 6 - STRUCTURAL STABILITY | 12 |
| 6.1 | Evaluation of Structural Stability | 12 |
| | SECTION 7 - ASSESSMENT/REMEDIAL MEASURES | 13 |
| 7.1 | Dam Assessment | 13 |
| 7.2 | Remedial Measures | 13 |

APPENDIX A - MAPS

| | |
|-----------|---------------------|
| Plate A-1 | Vicinity Topography |
| Plate A-2 | Location Map |

APPENDIX B - PHOTOGRAPHS

| | | |
|-----------|--------------|--|
| Plate B-1 | Photo Index | |
| Plate B-2 | Photo No. 2 | Emergency Spillway Looking Upstream |
| | Photo No. 3 | Principal Spillway Inlet |
| Plate B-3 | Photo No. 4 | Upstream Slope |
| | Photo No. 5 | Crest of Dam |
| Plate B-4 | Photo No. 6 | Downstream Slope |
| | Photo No. 7 | Outlet of Principal Spillway |
| Plate B-5 | Photo No. 8 | Principal Spillway Outlet Looking Downstream |
| | Photo No. 9 | Upstream From Right End |
| Plate B-6 | Photo No. 10 | Concrete Sill-Emergency Spillway |
| | Photo No. 11 | Upstream From Left End |

APPENDIX C - PROJECT PLATES

| | |
|-----------|--|
| Plate C-1 | Phase I - Plan and Centerline Profile of Dam |
| Plate C-2 | Phase I - Section of Dam |
| Plate C-3 | Phase I - Profile and Section of Spillway |

APPENDIX D - HYDRAULIC AND HYDROLOGIC DATA

| | |
|--------------------|---------------------------------------|
| Plates D-1 & D-2 | Hydrologic Computations |
| Plate D-3 | Emergency Spillway Rating Curve |
| Plate D-4 | Principal Spillway Rating Curve |
| Plate D-5 | Ratio-Discharge of PMF Curve |
| Plates D-6 to D-17 | Computer Input and Output for 1/2 PMF |

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

| | |
|--------------------|-----------------------|
| Name of Dam | Curt Lee Dam |
| State Located | Missouri |
| County Located | Gentry County |
| Stream | East Fork Grand River |
| Date of Inspection | May 15, 1979 |

↙
Curt Lee Dam was inspected by an interdisciplinary team of engineers, ~~from Hoskins-Western-Sonderregger, Inc.~~ The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately one mile downstream of the dam. Within the damage zone are three houses and State Highway 85.

↙
Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the volume of water impounded, the large floodplain downstream, the three houses, and State Highway 85 downstream of the dam, one-half of the Probable Maximum Flood is the appropriate spillway design flood. The spillway will pass the 100 year flood (flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillway will pass 17% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

No design data were available for this dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These analyses should be obtained in the future.

Other deficiencies observed during the inspection are several small willow trees growing on the upstream slope, slight erosion of the upstream face, and some erosion in the left downstream abutment trough.

Several items of preventative maintenance need to be initiated by the owner. These are described in detail in the body of the report.



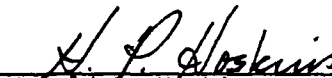
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Chairman of Board
Hoskins-Western-Sonderegger, Inc.
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PHOTO NO. 1 OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
CURT LEE DAM - MO 10664
GENTRY COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Curt Lee Dam be made.
- b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.
- c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams", dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances.
 - (1) The dam is an earthfill structure located in gently rolling topography in the northern Missouri loess and loess till physiographic area. The hilltops are mantled with a thin cover of loess. The slopes consist of Adair and Shelby type soils derived from fine textured glacial till. Alluvium in the valley is fine textured, derived from the loess mantle and the underlying till.
 - (2) The principal spillway is uncontrolled and consists of a 24 inch diameter steel pipe with riser located toward the left end of the dam in the old valley section.
 - (3) A vegetated earth spillway is cut through glacial till in the right abutment. The emergency spillway is uncontrolled.

(4) Pertinent physical data are given in paragraph 1.3 below.

- b. Location. The dam is located in the east central part of Gentry County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the SW $\frac{1}{4}$ of Section 30, T63N, R30W. The lake formed behind the dam is shown in the SW $\frac{1}{4}$ of Section 30, T63N, R30W.
- c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the small size category.
- d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph c above. Based on referenced guidelines, this dam is in the high hazard classification. The estimated damage zone extends approximately one mile downstream of the dam. Within the damage zone are three houses and State Highway 85.
- e. Ownership. The dam is owned by C. W. Lee, Rural Route 3, Albany, Missouri 64402.
- f. Purpose of Dam. The dam forms a 55 acre lake used primarily for recreational purposes.
- g. Design and Construction History. The following information is as reported by Mr. Lee, the owner. The site was drilled and samples tested by the Browning Co., located somewhere near Fulton, Mo. (These people were not located by the inspection team.) The site was surveyed and the dam designed by a firm in Savannah, Mo. The only data available from this firm were copies of survey notes for the centerline of the dam. The dam was constructed in 1971 by the Idecker Construction Co., Mound City, Mo. (These people were contacted but they were unable to supply any data.) A core trench was excavated along the centerline of the dam. This trench extended to a maximum depth of 20 to 25 feet in the valley bottom where a gravel stratum 10 to 15 feet wide and 4 to 5 feet in thickness was encountered and cut off. The clay fill material for the dam and core trench was borrowed from the south (left) side of the reservoir area. The material was compacted at "good" natural moisture with one self propelled and two pull sheepsfoot rollers.

Anti-seep collars were installed on the steel pipe principal spillway conduit.

- h. Normal Operating Procedure. There are no controlled outlet works for this dam. It was reported that the emergency spillway operated in about 1974 and that the lowest reservoir level occurred in 1977 when it receded to a level about 2 feet below the crest of the principal spillway riser.

1.3 PERTINENT DATA

- a. Drainage Area. 873 acres (1.36 square miles).

- b. Discharge at Damsite.

- (1) All discharges at the damsite are through an uncontrolled, 24 inch diameter ductile iron riser with a 24 inch diameter iron pipe outlet as the principal spillway and a grassed earth channel ungated emergency spillway.
- (2) Estimated maximum flood at damsite -- unknown.
- (3) The principal spillway capacity varies for 0 c.f.s. at elevation 890.0 feet to 28 c.f.s. at the crest of the emergency spillway (elevation 893.6 feet) to 39 c.f.s. at the minimum top of dam (elevation 895.5 feet).
- (4) The emergency spillway capacity varies from 0 c.f.s. at its crest elevation 893.6 feet to 256 c.f.s. at elevation 895.5 feet (minimum top of dam).
- (5) Total spillway capacity at the minimum top of dam is 295 c.f.s. \pm .

- c. Elevations (feet above M.S.L.).

- (1) Top of dam - 895.5 to 898.0
- (2) Principal spillway crest - 890.0
- (3) Emergency spillway crest - 893.6
- (4) Streambed at centerline - 869 \pm
- (5) Maximum tailwater - unknown

- d. Reservoir. Length (feet) of maximum pool - 2,500 \pm .

- e. Storage (Acre-feet).

- (1) Top of dam - 699 \pm
- (2) Principal spillway crest - 400 \pm

f. Reservoir Surface (Acres).

- (1) Top of dam - 63 ±
- (2) Principal spillway crest - 55 ±

g. Dam.

- (1) Type - Earth fill
- (2) Length - 850 feet ±
- (3) Height - 28 feet ±
- (4) Top width - 16 feet
- (5) Side slopes
 - (a) Downstream 3.4H to 1V (measured)
 - (b) Upstream 3H to 1V (measured on exposure)
- (6) Zoning - none reported
- (7) Impervious core - none reported
- (8) Cutoff - reported to be 5 to 25 feet in depth along centerline of dam
- (9) Grout curtain - none reported
- (10) Wave protection - durable limestone riprap, 6 to 8 inch nominal size

h. Diversion Channel and Regulating Tunnel. None.

i. Spillway.

- (1) Principal
 - (a) Type - uncontrolled, 24 inch diameter ductile iron riser with 24 inch diameter iron pipe conduit
 - (b) Crest (invert) elevation - 890.0 feet
Outlet - 869.0 feet
 - (c) Length - 150 feet ±
- (2) Emergency
 - (a) Type - vegetated earth with bottom width of approximately 25 feet and side slopes of 12H or 13H on 1V.
 - (b) Control section - concrete roadway, about 6 feet in width across the bottom of the spillway
 - (c) Crest elevation - 893.6 feet ±
 - (d) Upstream Channel - vegetated earth approximately 115 feet in length with slope of 3% ±
 - (e) Downstream Channel - vegetated earth with slope of 4% outletting into a side drainageway 300 to 400 feet downstream from the dam

j. Regulating Outlets. None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were available for this dam.

2.2 CONSTRUCTION

No construction data were available. It was reported that the dam was built in 1971. All other information reported by the owner on the construction of the dam are presented in Section 1.2, paragraph "g".

2.3 OPERATION

No data were available on spillway operation. It was reported that the emergency spillway operated in about 1974.

2.4 EVALUATION

- a. Availability. No data were available except as verbally reported by the owner.
- b. Adequacy. The field surveys, visual observation, and owner's reports presented herein are considered adequate to support the conclusion of this report. The owner worked with the Bureau of Reclamation and the Forest Service on the construction of earth dams in California. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.
- c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

- a. General. A visual inspection of the Curt Lee Dam and Appurtenances was made on May 15, 1979. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska making the inspection were: R. S. Decker, Geotechnical; Gordon Jamison, Hydrology; and Garold Ulmer, Civil Engineer. Photographs taken during the inspection are shown in Appendix B. Mr. C. W. Lee, owner, was present during the inspection.
- b. Dam.
 - (1) Geology and Soils (abutment and embankment). The dam is located in the northern Missouri loess-till physiographic province. Fine grained, dense, glacial till is exposed in a recent excavation on the right abutment some 200 feet north of the dam. The dam was reportedly constructed with clay fill material and drying cracks on the surface of the dam would tend to verify this report.
 - (2) Upstream Slope. The upstream slope is riprapped with durable limestone which extends up to or just above the elevation of the emergency spillway. Some slight erosion was noted along the upper edge of the riprap. Several small size willows are growing along the water line. The slope above the riprap is well vegetated with fescue and other adapted grasses. No cracks, abnormal deformations or serious erosion was noted on the upstream slope.
 - (3) Crest. The crest of the dam is well vegetated except for the roadway tracks. A few drying cracks were noted in the roadway tracks. Measurements on the crest indicate that the crest elevation is higher between Stations 2+00 to 3+20 ± than it is on either end of the dam. This is probably overfill placed during construction to compensate for foundation settlement. No abnormal deformations, other than the sloping profile, were noted along the crest.
 - (4) Downstream Slope. The downstream slope is well vegetated with fescue, clover and other grasses. Some erosion was noted in the left abutment trough. No indication of seepage was noted on the slope, at the toe or below the

toe of the dam. No slides, slumps, rodent holes or abnormal deformations were noted on the downstream slope.

- (5) Miscellaneous. The excellent vegetative cover and the erosion resistant materials in the dam would indicate that this structure could probably withstand overtopping for a sustained period of time without serious damage.

c. Appurtenant Structures.

- (1) The principal spillway is uncontrolled and consists of a 24 inch diameter ductile iron drop inlet riser 19 feet high connected to a 24 inch iron pipe outlet conduit. A woven wire trash rack surrounds the inlet. At the time of inspection, the reservoir level was barely above the crest of the riser. The pipe spillway discharges into a scour hole which is plated with waste concrete slabs and rubble. No significant erosion was noted in or around the scour hole and the exposed pipe did not show signs of deterioration.
- (2) The emergency spillway is a vegetated earth cut through glacial till in the right abutment. The roadway across the dam crosses the spillway on a concrete slab approximately 6 feet in width. This concrete slab serves as a control section for the spillway. The inlet and outlet sections of the spillway are well vegetated. No slides, deformations or erosion were noted in the emergency spillway. It was reported that a flow of 6 to 8 inches passed through the spillway in about 1974.
- (3) Drawdown Facilities. There are no drawdown facilities for this dam.

- d. Reservoir Area. The shoreline of the reservoir is well vegetated with adapted grasses and no significant erosion was noted around the reservoir. Water in the lake was very clear as a result of chemical treatment by the owner and excellent conservation management of the contributing watershed lands.

- e. Downstream Channel. The downstream channel is fairly open and passes under State Highway 85 in an 8 x 8 foot concrete box. A few small trees are growing along the outlet channel upstream from the road and several larger trees line the channel downstream from the road.

3.2 EVALUATION

The dam and appurtenances appear to be in excellent condition. The owner reported that he intends to remove the trees and treat the stumps and to place some more riprap on the upstream slope. The slopes of the dam and the materials in the dam would indicate adequate safety factors against shear failures. The nature of materials in the abutments and in the dam and the absence of any wetness on the downstream slope would indicate that excess seepage pressures will not endanger the safety of this structure. The nature of materials in the dam and the excellent vegetative cover indicate that minor overtopping would not endanger the safety of the structure.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

In general, the maintenance of the dam, appurtenances and the reservoir area has been good. The few small trees should be removed and minor erosion repaired on the upstream face.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

There does not appear to be any serious potential of failure of this structure.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data. No design data were found for this dam. All computations are based on the field inspection and survey by the consultant. The plan, profiles, and cross sections from the survey are attached in Appendix C.
- b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Darlington, Missouri 15 minute topographic quadrangle map. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection.
- c. Visual Observations.
 - (1) Principal and emergency spillways are in good condition.
 - (2) The emergency spillway and exit channel are in the right hillside abutment away from the dam. Spillway releases will not endanger the integrity of the dam.
 - (3) An 8' x 8' concrete box culvert is located in channel approximately 150 feet downstream of outlet.
 - (4) No drawdown facilities are available to evacuate the pool.
- d. Overtopping Potential. The spillways are too small to pass 50% of the probable maximum flood without overtopping. The spillways will pass 17% of the PMF without overtopping. The 100-year (1 percent) peak outflow discharge is approximately 100% of the spillway capacity. The effect of overtopping on the structural or erosional stability of this dam is expected to be minimal. The results of the routings through the dam are tabulated in regards to the following conditions.

| Frequency | Inflow Discharge c.f.s. | Outflow Discharge c.f.s. | Maximum Pool Elevation | Freeboard Top of Dam Min. Elev. 895.5 | Time Dam Overtopping Hr. |
|-----------|-------------------------------|--------------------------------|------------------------------|--|-----------------------------------|
| 100 Yr. | 3000 | 300 | 895.5 | 0 | 0 |
| 1/2 PMF | 4700 | 3900 | 897.7 | -2.2 | 10± |
| PMF | 9400 | 8700 | 898.6 | -3.1 | 11+ |
| 0.17 PMF | 1600 | 300 | 895.5 | 0 | 0 |

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and a small size. Therefore, the 1/2 PMF to PMF is the test for the adequacy of the dam and its spillways.

The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observation. The dam appears to be structurally stable. The embankment slopes should provide adequate safety factors against shear failures for a dam of this height. There were no seeps, slides or deformations noted on the embankment or abutments. Additional studies would be required to determine the effects of overtopping on structural stability. However, it appears that the safety of the dam would not be impaired by minor overtopping.
- b. Design and Construction Data. No design or construction data were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.
- c. Operating Records. There are no controlled operating facilities for this dam.
- d. Post Construction Changes. No post construction changes were reported for this dam.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

- a. Safety. Using the approximate data available for analysis, the dam will be overtopped 2.2 foot by one-half the Probable Maximum Flood. The duration of overtopping would be approximately 10 hours. The effect of such overtopping on the structural and erosional stability of the dam is not known. However, it is felt that such overtopping would not endanger the safety of this dam.
- b. Adequacy of Information. Due to the lack of engineering data, the conclusions in this report are based upon performance history and visual observations. Seepage and stability analyses comparable to the requirements of the guidelines were not available which is considered a deficiency.
- c. Urgency. The item recommended in 7.2a should be pursued on a high priority basis.
- d. Necessity for Phase II. Phase II investigation is not considered necessary.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam.

7.2 REMEDIAL MEASURES

- a. Alternatives.

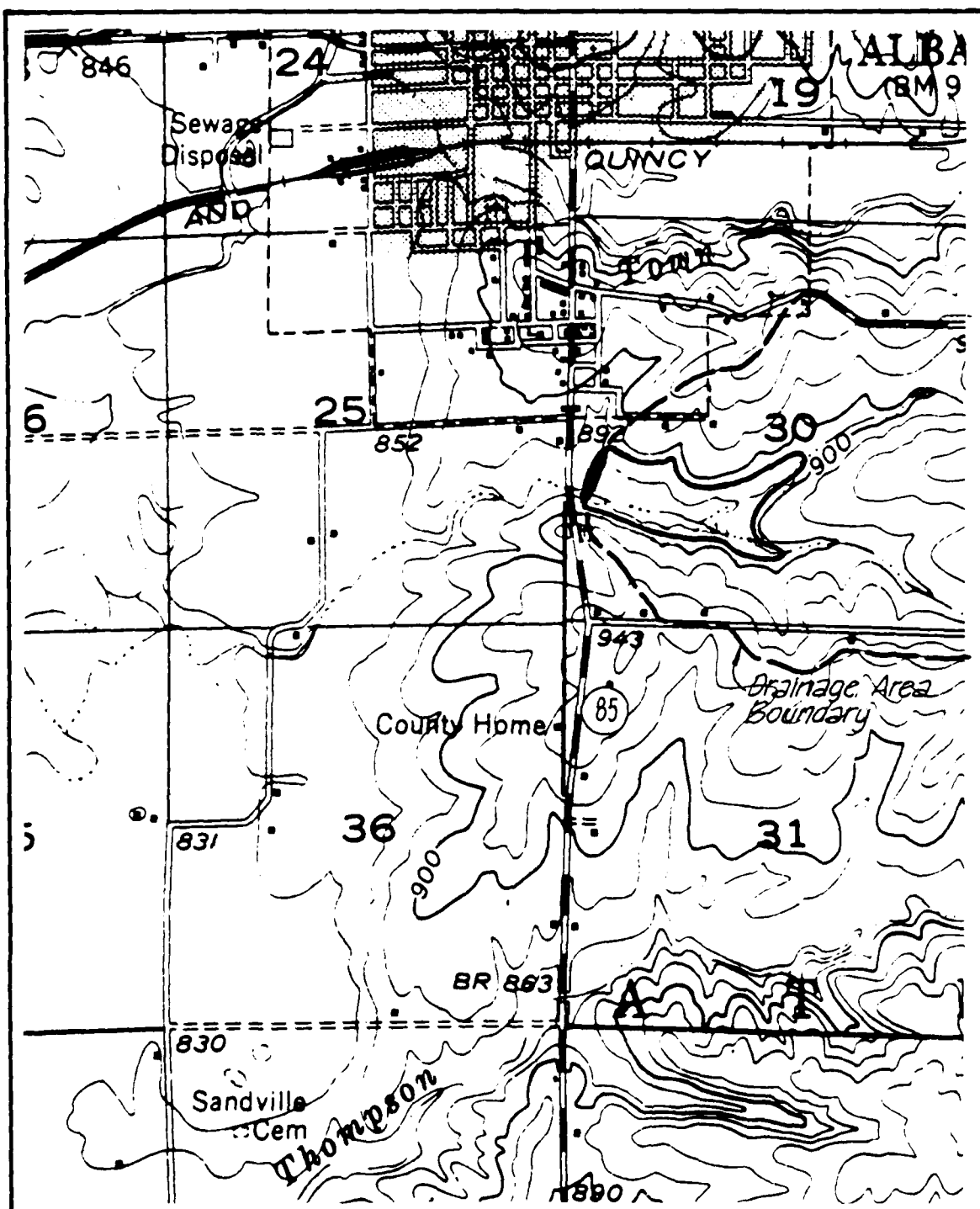
Additional information should be obtained on the topographic characteristics of the reservoir area to determine the increase in the height of dam or the size of the spillway that is necessary to pass one-half the Probable Maximum Flood without overtopping the dam. The services of an engineer experienced in the design of dams should be obtained to evaluate the present reservoir storage capacity, to provide seepage and stability analyses of the present dam, and to design protective measures, if required.

- b. O & M Procedures

- (1) Trees and shrubs growing on the upstream slope should be removed and measures taken to prevent their recurrence.

- (2) Minor erosional damage on the upstream slope should be repaired.
- (3) The dam should be periodically inspected by an experienced engineer and records kept of these inspections and maintenance.

APPENDIX A
MAPS



Scale in feet
2000 1000 0 2000 4000

Contour Interval 20 Feet

N



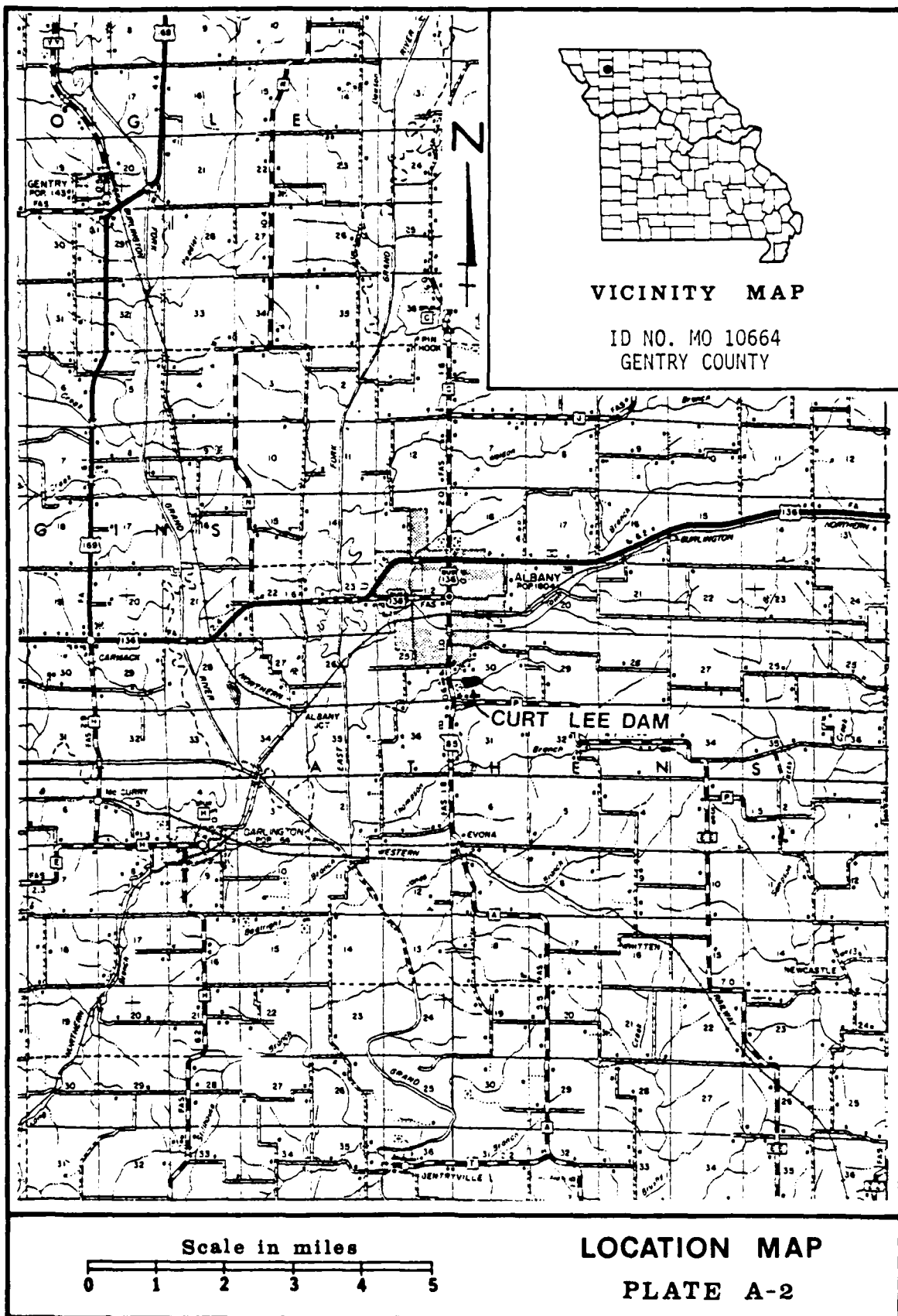
VICINITY TOPOGRAPHY

CURT LEE DAM

GENTRY COUNTY, MISSOURI

MO. 10664

PLATE A-1



APPENDIX B
PHOTOGRAPHS

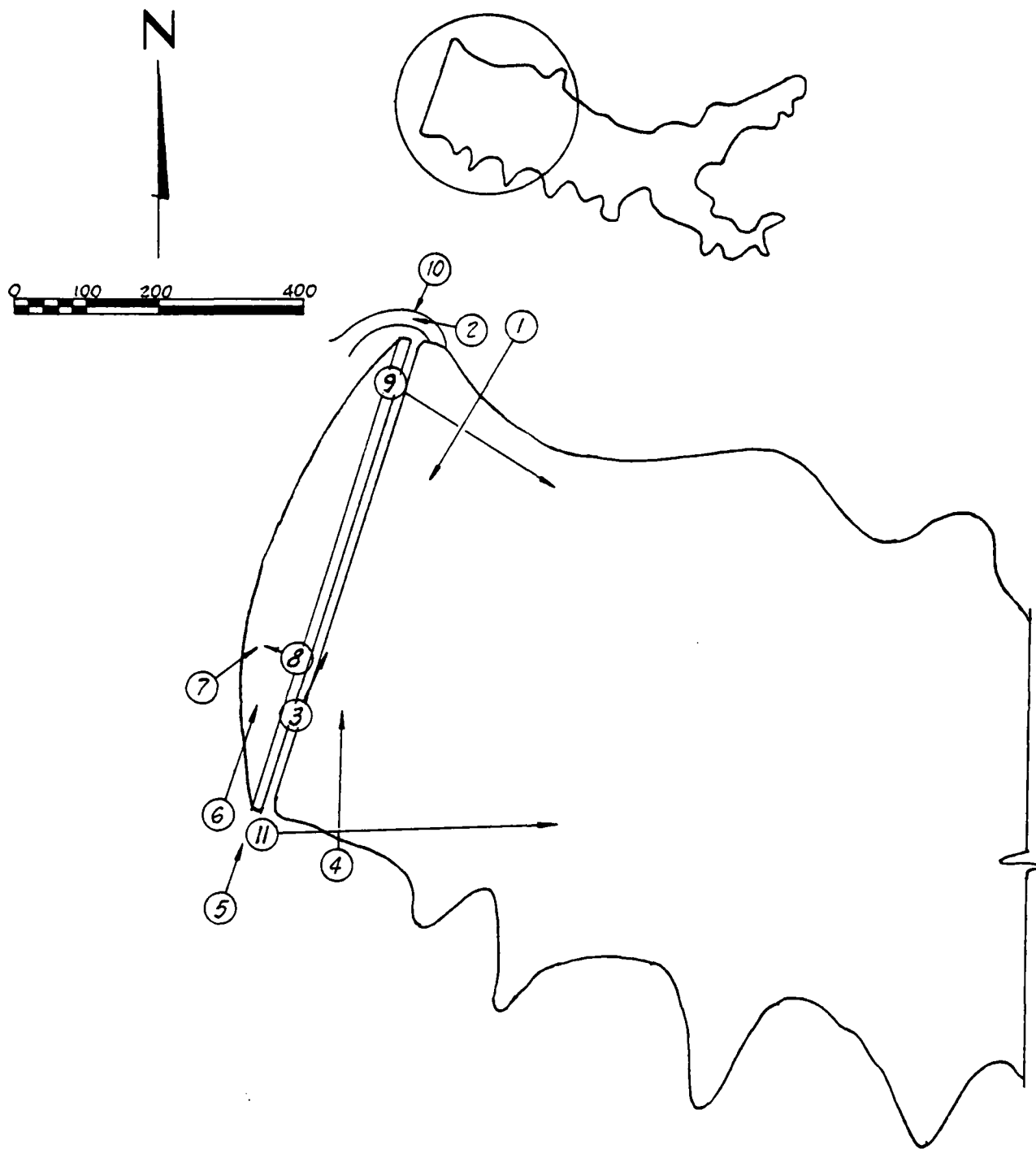


PHOTO INDEX
CURT LEE DAM
GENTRY COUNTY, MISSOURI
MO. 10664
PLATE B-1



PHOTO NO. 2 - EMERGENCY SPILLWAY LOOKING DOWNSTREAM.



PHOTO NO. 3 - PRINCIPAL SPILLWAY INLET.



PHOTO NO. 4 - UPSTREAM SLOPE. NOTE EROSION.



PHOTO NO. 5 - CREST OF DAM TAKEN FROM LEFT END.



PHOTO NO. 6 - DOWNSTREAM SLOPE TAKEN FROM LEFT END.



PHOTO NO. 7 - OUTLET OF PRINCIPAL SPILLWAY.



PHOTO NO. 8 - PRINCIPAL SPILLWAY OUTLET LOOKING DOWNSTREAM.



PHOTO NO. 9 - LOOKING UPSTREAM FROM RIGHT END.



PHOTO NO. 10 - CONCRETE SILL ACROSS EMERGENCY SPILLWAY.



PHOTO NO. 11 - UPSTREAM FROM LEFT END.

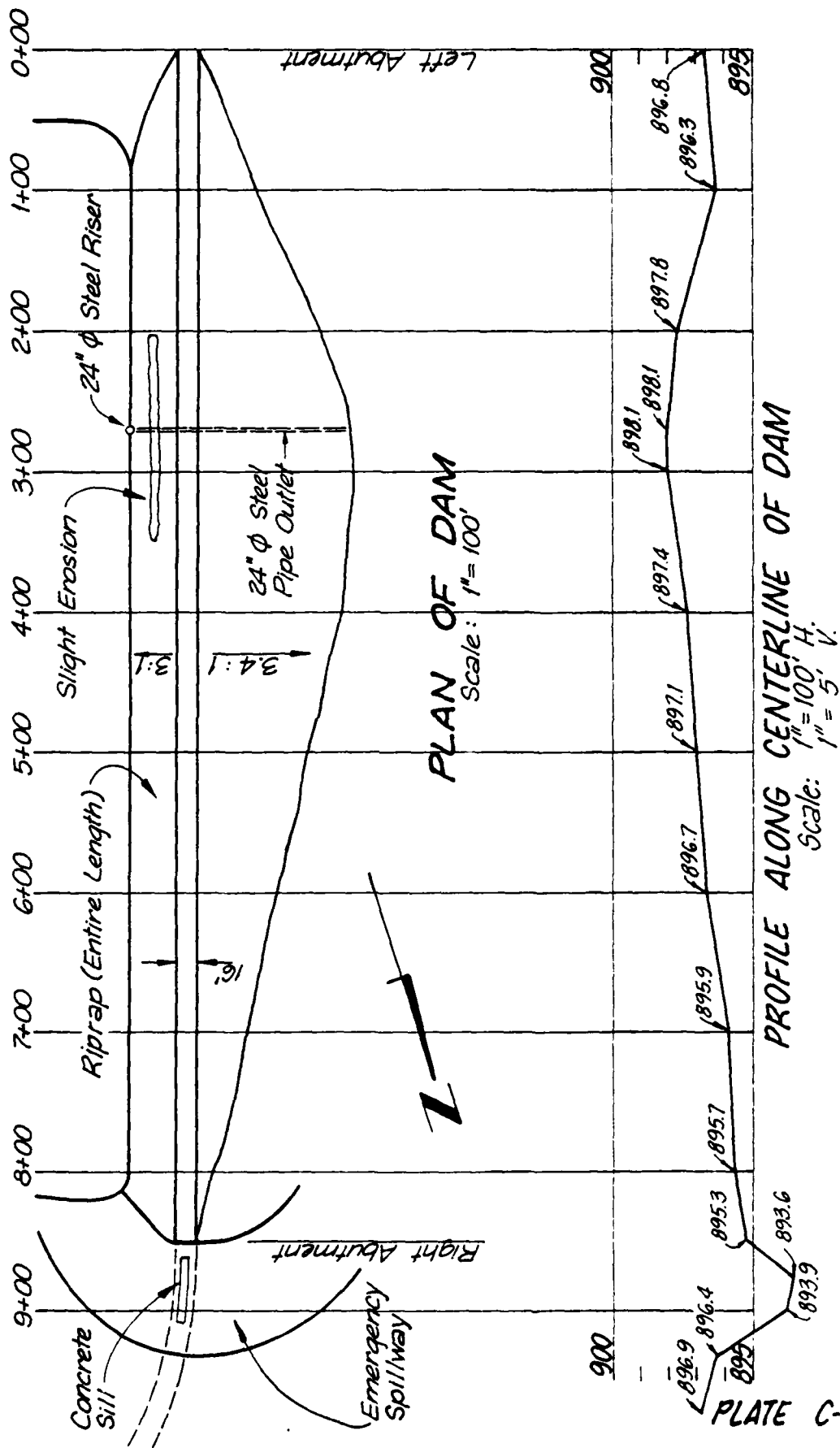
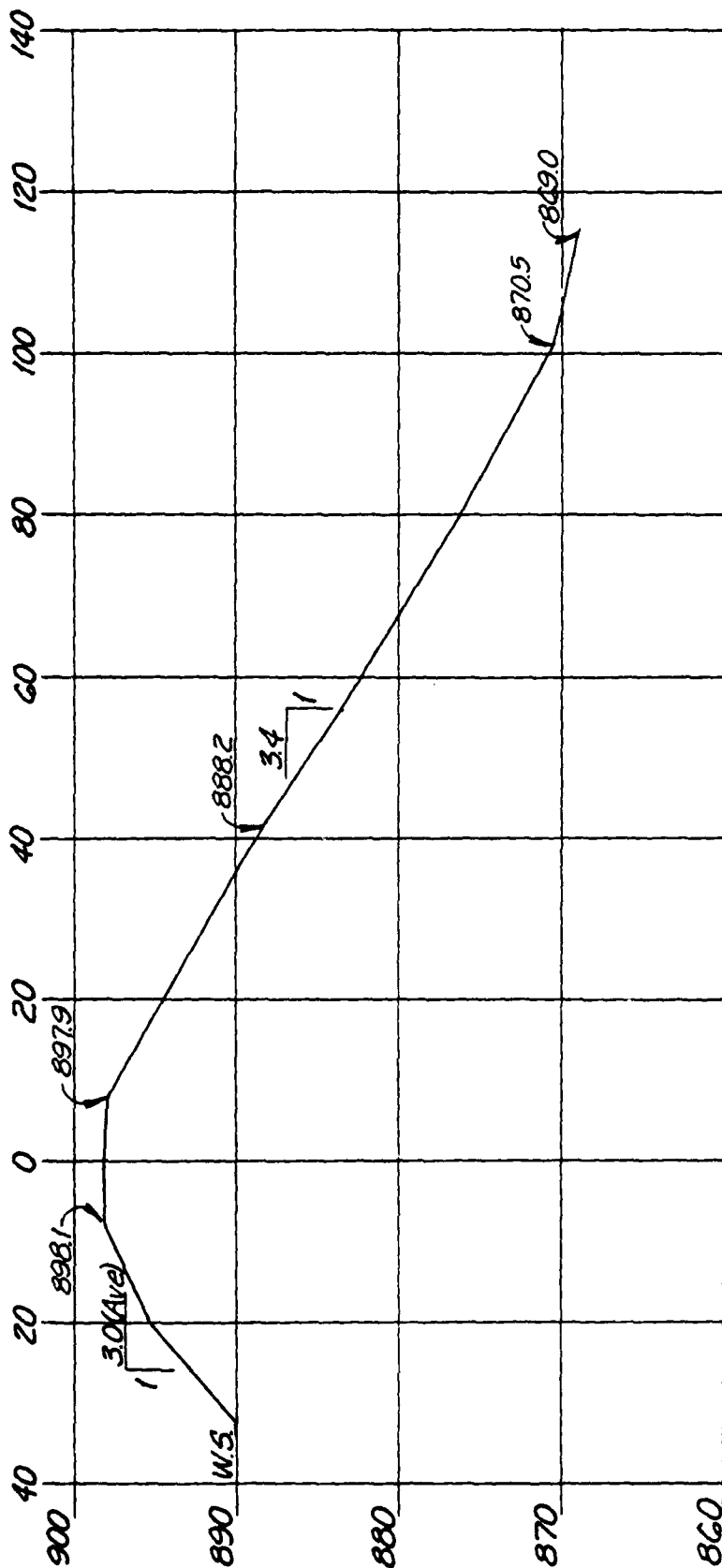


PLATE C-1



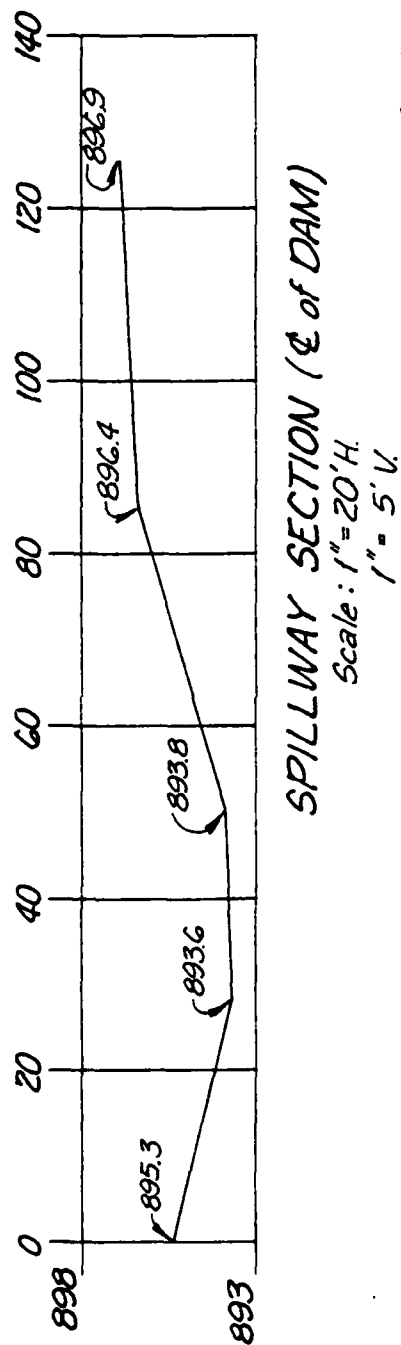
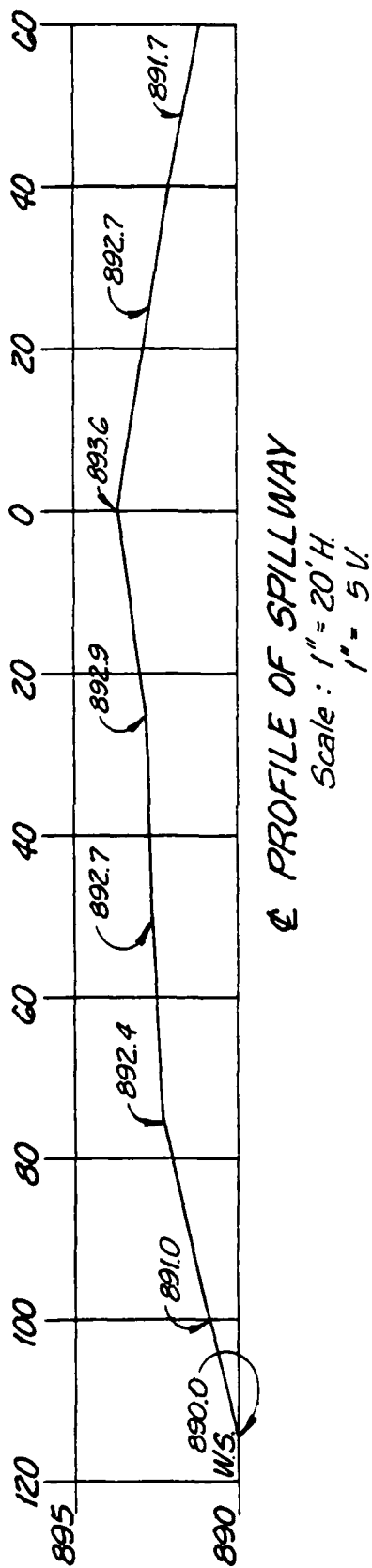
SECTION @ STA. 2+70

Scale: 1" = 20' H.

1" = 10' V.

CURT LEE DAM

PLATE C-2



CURT LEE DAM

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs.

a. Twenty-four hour, 100-year rainfall for the dam location was taken from the data for the rainfall station at Maryville, Mo. as supplied by the St. Louis District, Corps of Engineers per their letter dated 6 March 1979. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.

b. Drainage area = 1.36 square miles (873 acres).

c. Time of concentration of runoff = 49 minutes (computed from "Kirpich" formula).

d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the 100-year precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the sill of the riser.

e. The total twenty-four hour storm duration losses for the 100-year storm were 1.75 inches. The total losses for the PMF storm were 0.75 inches. These data are based on SCS runoff curve No. 94 and No. 85 for antecedent moisture conditions SCS AMC III and AMC II respectively. The watershed is composed of primarily SCS soil group C and consists of primarily pasture with some cropland and woodland.

f. Average soil loss rates = 0.03 inch per hour approximately (for PMF storm, AMC III).

2. The discharge rating for the principal spillway was developed using the standard weir and orifice equations. They are as follows:

- a. Weir flow equation - $Q = CLH^{3/2}$
where C = weir coefficient = 3.1
L = weir length, ft. = 6.28
H = total head, ft.

b. Orifice flow equation - $Q = CA\sqrt{2gH}$

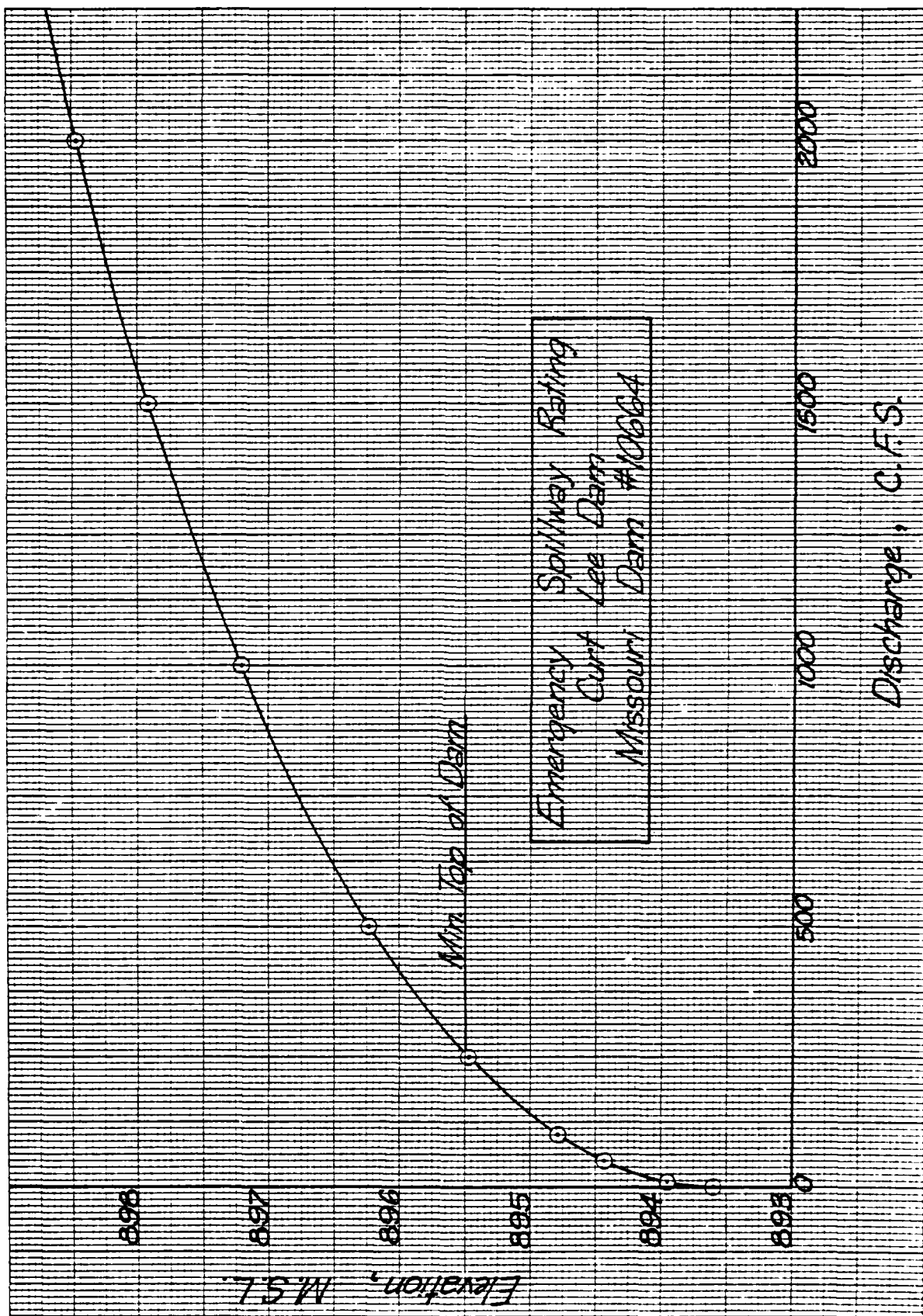
where C = Orifice coefficient = 0.6

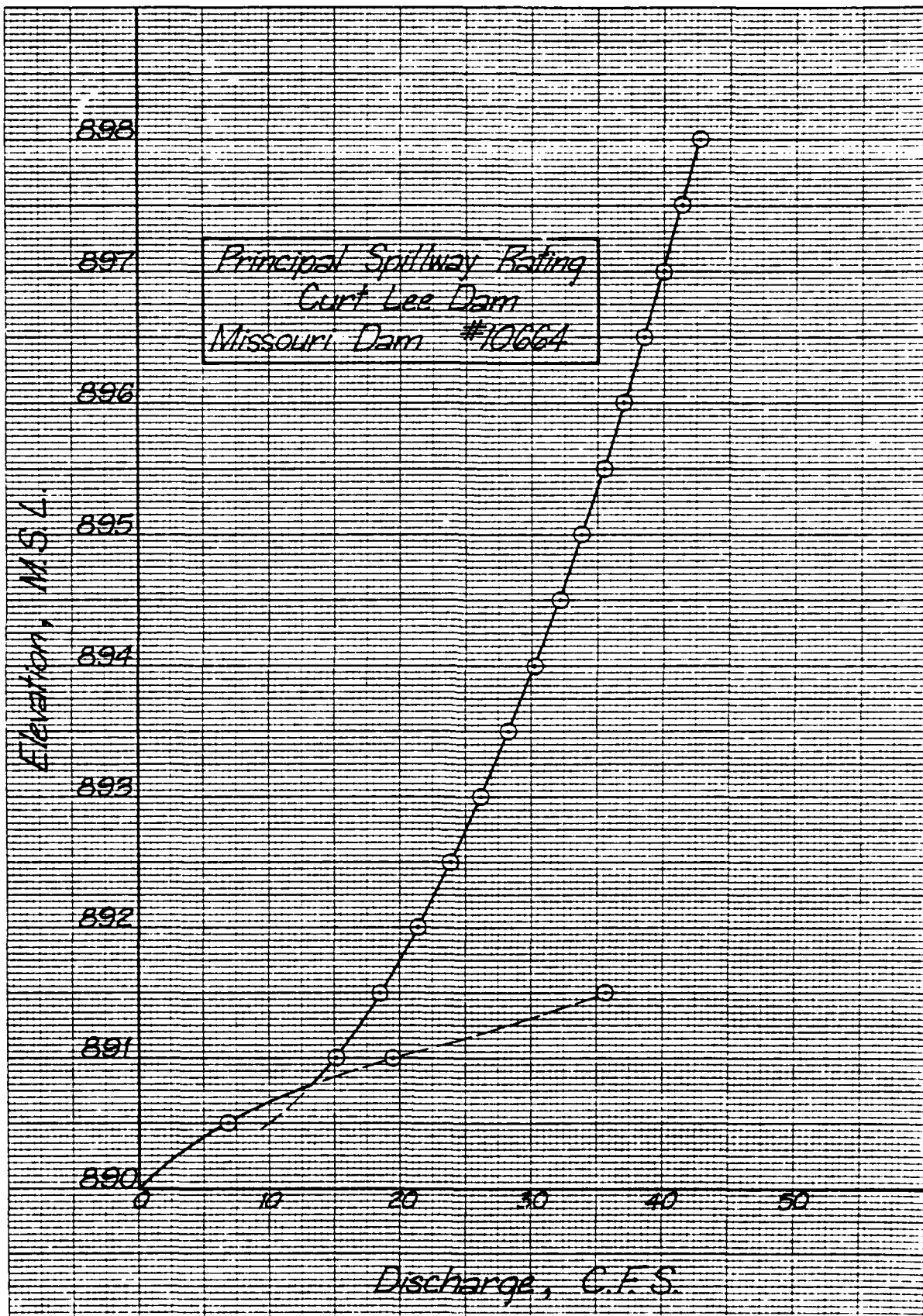
A = area, sf. = 3.142

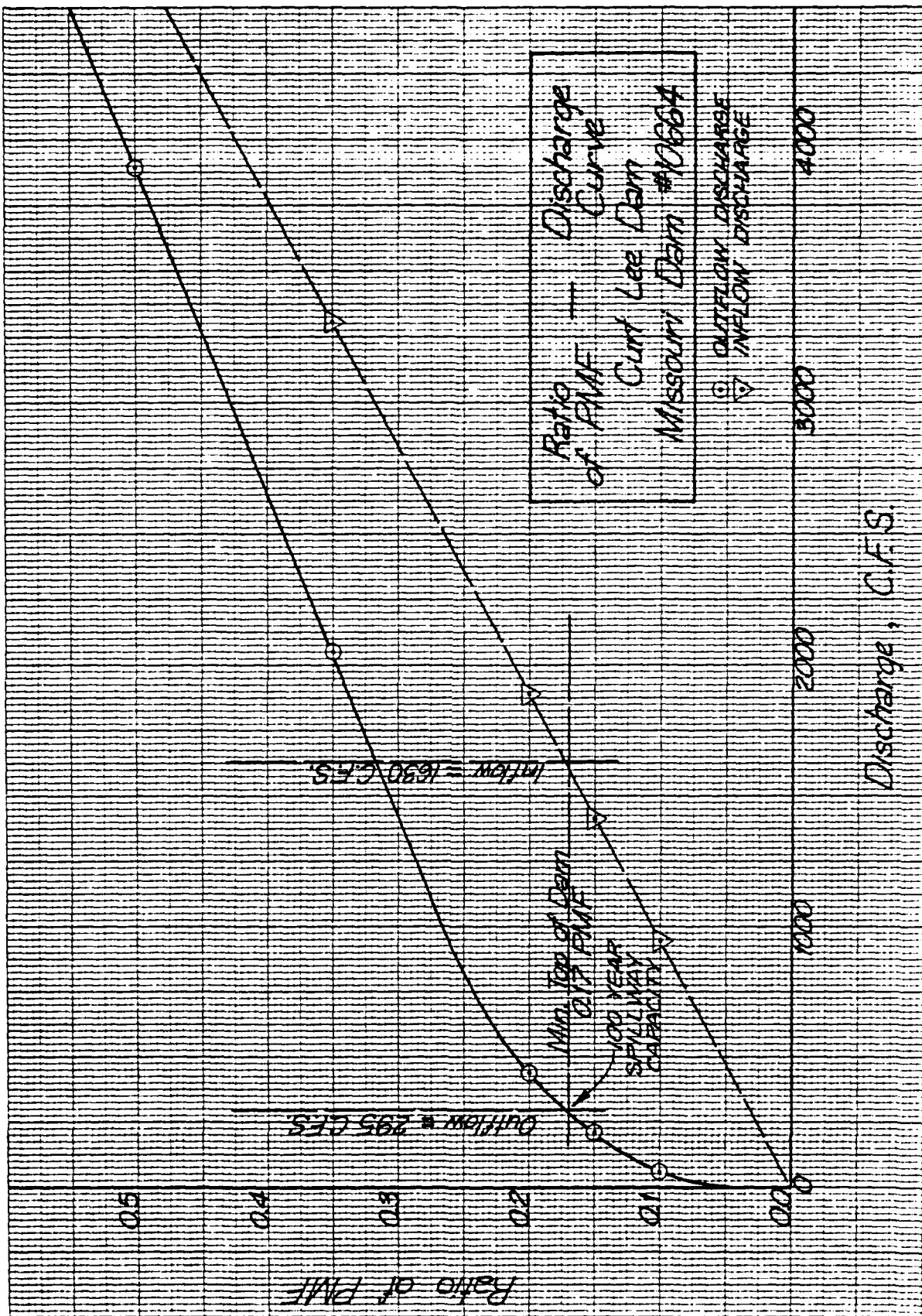
H = total head, ft.

The emergency spillway discharge rating was developed using the Corps of Engineers Surface Water Profile HEC-2 computer program. The flows over the dam were developed using the dam overtopping analysis (Flow over non-level dam crest) within the HEC-1 (Dam Safety Version) program.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The input and output data sheets for the one-half PMF are attached as Appendix D.







 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

RUN DATE 79/09/05.
 TIME 18.31.33.

ANALYSIS OF DAM OVERTOPPING USING PM
 HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF CURTILL DAM 100%
 PM ROUTED THROUGH THE RESERVOIR

| JCM SPECIFICATION | | | | | | | | | |
|-------------------|----|-----|-------|-----|-------|-------|------|-------|---|
| NO | HR | IMP | DAY | TH | MIN | NETP | IPIT | RSIAT | |
| 248 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| | | | JOPER | NAT | TRCPT | TRACE | | | |
| | | | 5 | 0 | 0 | 0 | | | |

MULTI-PLAN ANALYSES TO BE PERFORMED

RTIOS= .10 .15 .20 .25 .50 1.00
 NPLAN= 1 NRATIO= 6 LRTIO= 1

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH TO 100% RES

| ISIAQ | ICOMP | TECH | TRAP | JPT | IPRT | INACH | ESTAGE | TAJED |
|--------|-------|------|------|-----|------|-------|--------|-------|
| 0.0001 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| HYDG | TIME | AREA | SNAP | TRSDA | TRSPC | RATIO | 15704 | 15404 | LOCAL |
|------|------|------|------|-------|-------|-------|-------|-------|-------|
| 1 | 1.36 | 0.00 | 1.36 | 1.00 | 0.00 | 0 | 1 | 0 | |

PRECIP DATA

| SPTC | PMS | RE | R12 | R24 | R48 | R72 | R96 |
|------|-------|--------|--------|--------|------|------|------|
| 0.00 | 23.40 | 102.00 | 121.00 | 110.00 | 0.00 | 0.00 | 0.00 |

LOSS DATA

| LRDPT | STMR | DLTR | RTUL | ERAP | STRES | RTIOW | STRIC | CNSTI | ALSHR | PTIOW |
|-------|------|------|------|------|-------|-------|-------|--------|-------|-------|
| 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 1.00 | -1.00 | -94.00 | 0.00 | 0.00 |

CURVE NO = 1.00 WITH SS = -1.00 EFFECT CN = 94.00

UNIT HYDROGRAPH DATA
 TC = 0.00 LAG = .40

PRECISION DATA
 SLOPE = 0.00 SLOPE = .10 EFFECT = 1.00

UNIT HYDROGRAPH AT 100% OF PERIOD OF RATES, TC = 0.00, LAG = .40, SLOPE = 1.00, EFFECT = 1.00

| TIME | AREA | SNAP | TRSDA | TRSPC | RATIO | 15704 | 15404 | LOCAL |
|------|------|------|-------|-------|-------|-------|-------|-------|
| 1.36 | 0.00 | 1.36 | 1.00 | 0.00 | 0 | 1 | 0 | |

HYDROGRAPH AT STATION 001 FOR PLAN 1, PLOT 6

PEAK 6-FCUR 24-HOUR 72-HOUR TOTAL VOLUME
 954. 3470. 1228. 1250. 372179.
 267. 93. 36. 36. 10256.
 INCHES 23.69 34.33 34.34 34.33
 201.61 872.01 872.01 872.01
 1721. 2494. 2494. 2494.
 2123. 3077. 3077. 3077.
 AC-IT
 THOUS CU M

HYDROGRAPH ROUTING

ROUTED FLOODS THRU 10664 RES

1STAG 1ECUN 1TAPC 1PRT 1PRT 1STAG 1AOUT
 000002 1 0 0 2 0 0 0
 ROUTING DATA
 QLOSS CLOSS AVG 1RCS 1SAFE 1UPT 1PMP 1STR
 0.0 0.000 0.00 1 1 0 0 0

NSTPS NSTOL LAG ANSKK X TSK STORA 1SPAT
 1 0 0 0.000 0.000 0.000 -890. -1

| STAGE | 890.00 | 890.50 | 891.00 | 891.50 | 892.00 | 892.50 | 893.00 | 893.50 | 894.00 | 894.50 | 895.00 |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| FLOW | 0.00 | 7.00 | 15.00 | 18.00 | 21.00 | 24.00 | 26.00 | 28.00 | 30.00 | 32.00 | 34.00 |
| CAPACITY= | 0. | 25. | 85. | 210. | 400. | 660. | 1052. | 1460. | 2060. | | |
| ELEVATION= | 870. | 875. | 880. | 885. | 890. | 895. | 900. | 905. | 910. | | |

CURV SPWID 100M EXPD ELEV 100M 100M 100M
 890.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DAM DATA

1CUP1 1CUC1 1EXP1 1DAMP1D
 895.5 3.0 1.5 950.

| CRIST LENGTH AT CR INFLU | 895.5 | 895.7 | 896.0 | 896.3 | 896.7 | 897.0 | 897.3 | 897.6 | 897.9 | 898.2 | 898.5 |
|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| ELEVATION | 895.5 | 895.7 | 896.0 | 896.3 | 896.7 | 897.0 | 897.3 | 897.6 | 897.9 | 898.2 | 898.5 |

STATION 000002, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORIGINATES

| CRIST LENGTH AT CR INFLU | 895.5 | 895.7 | 896.0 | 896.3 | 896.7 | 897.0 | 897.3 | 897.6 | 897.9 | 898.2 | 898.5 |
|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| ELEVATION | 895.5 | 895.7 | 896.0 | 896.3 | 896.7 | 897.0 | 897.3 | 897.6 | 897.9 | 898.2 | 898.5 |

DATE DOCUMENTED: 1/1/00

01010

STAT 100000002

| | 0. | 1000. | 2000. | 3000. | 4000. | 5000. | 0. | 10. | 20. | 30. | 40. | 50. | 60. | 70. | 80. | 90. | 0. |
|----------|----|-------|-------|-------|-------|-------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| .05 11 | | | | | | | | | | | | | | | | | |
| .10 21 | | | | | | | | | | | | | | | | | |
| .15 31 | | | | | | | | | | | | | | | | | |
| .20 41 | | | | | | | | | | | | | | | | | |
| .25 51 | | | | | | | | | | | | | | | | | |
| .30 61 | | | | | | | | | | | | | | | | | |
| .35 71 | | | | | | | | | | | | | | | | | |
| .40 81 | | | | | | | | | | | | | | | | | |
| .45 91 | | | | | | | | | | | | | | | | | |
| .50 101 | | | | | | | | | | | | | | | | | |
| .55 111 | | | | | | | | | | | | | | | | | |
| 1.00 121 | | | | | | | | | | | | | | | | | |
| 1.05 131 | | | | | | | | | | | | | | | | | |
| 1.10 141 | | | | | | | | | | | | | | | | | |
| 1.15 151 | | | | | | | | | | | | | | | | | |
| 1.20 161 | | | | | | | | | | | | | | | | | |
| 1.25 171 | | | | | | | | | | | | | | | | | |
| 1.30 181 | | | | | | | | | | | | | | | | | |
| 1.35 191 | | | | | | | | | | | | | | | | | |
| 1.40 201 | | | | | | | | | | | | | | | | | |
| 1.45 211 | | | | | | | | | | | | | | | | | |
| 1.50 221 | | | | | | | | | | | | | | | | | |
| 1.55 231 | | | | | | | | | | | | | | | | | |
| 2.00 241 | | | | | | | | | | | | | | | | | |
| 2.05 251 | | | | | | | | | | | | | | | | | |
| 2.10 261 | | | | | | | | | | | | | | | | | |
| 2.15 271 | | | | | | | | | | | | | | | | | |
| 2.20 281 | | | | | | | | | | | | | | | | | |
| 2.25 291 | | | | | | | | | | | | | | | | | |
| 2.30 301 | | | | | | | | | | | | | | | | | |
| 2.35 311 | | | | | | | | | | | | | | | | | |
| 2.40 321 | | | | | | | | | | | | | | | | | |
| 2.45 331 | | | | | | | | | | | | | | | | | |
| 2.50 341 | | | | | | | | | | | | | | | | | |
| 2.55 351 | | | | | | | | | | | | | | | | | |
| 3.00 361 | | | | | | | | | | | | | | | | | |
| 3.05 371 | | | | | | | | | | | | | | | | | |
| 3.10 381 | | | | | | | | | | | | | | | | | |
| 3.15 391 | | | | | | | | | | | | | | | | | |
| 3.20 401 | | | | | | | | | | | | | | | | | |
| 3.25 411 | | | | | | | | | | | | | | | | | |
| 3.30 421 | | | | | | | | | | | | | | | | | |
| 3.35 431 | | | | | | | | | | | | | | | | | |
| 3.40 441 | | | | | | | | | | | | | | | | | |
| 3.45 451 | | | | | | | | | | | | | | | | | |
| 3.50 461 | | | | | | | | | | | | | | | | | |
| 3.55 471 | | | | | | | | | | | | | | | | | |
| 4.00 481 | | | | | | | | | | | | | | | | | |
| 4.05 491 | | | | | | | | | | | | | | | | | |
| 4.10 501 | | | | | | | | | | | | | | | | | |
| 4.15 511 | | | | | | | | | | | | | | | | | |
| 4.20 521 | | | | | | | | | | | | | | | | | |
| 4.25 531 | | | | | | | | | | | | | | | | | |
| 4.30 541 | | | | | | | | | | | | | | | | | |
| 4.35 551 | | | | | | | | | | | | | | | | | |
| 4.40 561 | | | | | | | | | | | | | | | | | |

4.45 5.11
 4.50 5.61
 4.55 5.51
 5.00 6.01
 5.05 6.11
 5.10 6.21
 5.15 6.31
 5.20 6.41
 5.25 6.51
 5.30 6.61
 5.35 6.71
 5.40 6.81
 5.45 6.91
 5.50 7.01
 5.55 7.11
 6.00 7.21
 6.05 7.31
 6.10 7.401
 6.15 7.51
 6.20 7.61
 6.25 7.701
 6.30 7.801
 6.35 7.901
 6.40 8.001
 6.45 8.101
 6.50 8.201
 6.55 8.301
 7.00 8.401
 7.05 8.501
 7.10 8.601
 7.15 8.701
 7.20 8.801
 7.25 8.901
 7.30 9.001
 7.35 9.101
 7.40 9.201
 7.45 9.301
 7.50 9.401
 7.55 9.501
 8.00 9.601
 8.05 9.701
 8.10 9.801
 8.15 9.901
 8.20 10.001
 8.25 10.101
 8.30 10.201
 8.35 10.301
 8.40 10.401
 8.45 10.501
 8.50 10.601
 8.55 10.701
 9.00 10.801
 9.05 10.901
 9.10 11.001
 9.15 11.101
 9.20 11.201
 9.25 11.301
 9.30 11.401
 9.35 11.501
 9.40 11.601
 9.45 11.701
 9.50 11.801

5.501194
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 10.051210
 10.101220
 10.151230
 10.201240
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 10.351270
 10.401280
 10.451290
 10.501300
 10.551310
 11.001320
 11.051330
 11.101340
 11.151350
 11.201360
 11.251370
 11.301380
 11.351390
 11.401400
 11.451410
 11.501420
 11.551430
 12.001440
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 12.251490
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 12.551550
 13.001560
 13.051570
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 13.151590
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 13.351630
 13.401640
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 14.051690
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 14.201720
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 14.301740
 14.351750
 14.401760
 14.451770
 14.501780
 14.551790
 15.001800

| | |
|-----------|----|
| 20.1-24.1 | 10 |
| 20.20244 | 10 |
| 20.25245 | 10 |
| 20.30246 | 10 |
| 20.35247 | 10 |
| 20.40248 | 10 |
| 20.45249 | |
| 20.50250 | |
| 20.55251 | |
| 21.00252 | |
| 21.05253 | |
| 21.10254 | |
| 21.15255 | |
| 21.20256 | |
| 21.25257 | |
| 21.30258 | |
| 21.35259 | |
| 21.40260 | |
| 21.45261 | |
| 21.50262 | |
| 21.55263 | |
| 22.00264 | |
| 22.05265 | |
| 22.10266 | |
| 22.15267 | |
| 22.20268 | |
| 22.25269 | |
| 22.30270 | |
| 22.35271 | |
| 22.40272 | |
| 22.45273 | |
| 22.50274 | |
| 22.55275 | |
| 23.00276 | |
| 23.05277 | |
| 23.10278 | |
| 23.15279 | |
| 23.20280 | |
| 23.25281 | |
| 23.30282 | |
| 23.35283 | |
| 23.40284 | |
| 23.45285 | |
| 23.50286 | |
| 23.55287 | |
| 24.00288 | |

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PEAK-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (TUBIC FEET PER SECOND)
 AREA IN SQUARE FEET (SQUARE METERS)

| OPERATION | STATION | AREA | PLAN | RATIO | RATIOS APPLIED TO FLOWS | | | | | |
|---------------|---------|-------|------|---------|-------------------------|---------|---------|----------|----------|------|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 |
| | | | | | .10 | .15 | .20 | .35 | .50 | 1.00 |
| HYDROGRAPH AT | 000001 | 1.36 | 1 | 944. | 1417. | 1009. | 9306. | 4222. | 5444. | |
| | | 3.531 | (| 26.7411 | 40.1211 | 53.6911 | 94.6011 | 134.7211 | 267.4411 | |
| ROUTED TO | 000002 | 1.36 | 1 | 58. | 209. | 440. | 2050. | 3898. | 8664. | |
| | | 3.531 | (| 1.6411 | 5.9111 | 12.4611 | 59.0511 | 110.3811 | 245.3311 | |

SOURCE OF CAP SAFETY ANALYSIS

PLATE 1

| RATIO OF PPE | MAXIMUM RESERVOIR WATER LEVEL | ELEVATION SURFACE EFFECT | INITIAL VALUE 850.00 600.00 0.00 | SPILLWAY CAPACITY 800.00 600.00 0.00 | TOP OF DAM 900.00 700.00 500.00 | TIME OF MAX FLOW HOURS | TIME OF MAX FLOW HOURS | TIME OF FALLING HOURS |
|--------------------|--|--------------------------------|---|---|--|------------------------------|------------------------------|-----------------------------|
| | | | | | | | | |
| .10 | 894.16 | | 616.00 | 51.00 | 0.00 | 24.00 | 24.00 | 0.00 |
| .15 | 895.16 | | 672.00 | 279.00 | 0.00 | 10.00 | 10.00 | 0.00 |
| .20 | 895.88 | | 729.00 | 440.00 | 0.00 | 16.00 | 16.00 | 0.00 |
| .25 | 897.08 | | 823.00 | 2050.00 | 0.00 | 16.00 | 16.00 | 0.00 |
| .30 | 897.65 | | 823.00 | 3376.00 | 0.00 | 16.00 | 16.00 | 0.00 |
| 1.00 | 898.55 | | 541.00 | 8664.00 | 11.54 | 16.17 | 16.17 | 0.00 |

**DAT
FILM**